State of California
AIR RESOURCES BOARD

DRAFT PRELIMINARY STAFF REPORT

PROPOSED AMENDMENTS TO CALIFORNIA'S LOW-EMISSION VEHICLE REGULATIONS "LEV II"

Proposed Modifications to the California Exhaust, Evaporative and Onboard Refueling Vapor Recovery Emission Standards and Test Procedures for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles

Date of Release: November 7, 1997
Workshop: December 9, 1997

Mobile Source Control Division
9528 Telstar Avenue
El Monte, California 91731

TABLE OF CONTENTS

Proposed Amendments to California's Low-Emission Vehicle Regulations "LEV II"

I. Introduction

Even though California has made great strides towards cleaner air, significant further reductions of oxides of nitrogen ("NOx") and reactive organic gas ("ROG") emissions are necessary to reach ozone attainment. The mobile source element of California's 1994 State Implementation Plan ("SIP") calls for adoption of technology-based emission control strategies for light-duty vehicles (Measure M2 - Improved Control Technologies for Light-Duty Vehicles) that anticipate emission reductions of 25 tons per day (tpd) ROG plus NOx in 2010. The scheduled implementation date for this measure is 2004. In addition to Measure M2, the SIP recognizes that areas designated as extreme ozone nonattainment (specifically, the South Coast Air Basin) may need to rely on the development of additional technology measures as specified in Section 182(e)(5) of the Clean Air Act Amendments of 1990 in order to achieve required air quality goals. The amount of emission reductions needed from the South Coast Air Basin is approximately 75 tpd ROG plus NOx (the inventory of these emissions is referred to as the "Black Box").

The amendments being proposed in this rulemaking would help meet the emission reduction goals of M2 and would achieve additional reductions attributable to the "Black Box." The proposed amendments would affect passenger cars, light-duty trucks and some medium-duty vehicles, and would include lower tailpipe standards, lower fleet average non-methane organic gas (NMOG) standards, a zero evaporative and refueling emission standard, modifications to the Smog Index Label to reflect the proposed emission standards and fleet average requirement beyond 2003, modifications to hybrid electric vehicle test procedures for all light- and medium-duty vehicles, and other measures. Staff will also review data on the specific reactivity of late model low-emission vehicles relative to the generic reactivity adjustment factors (RAF) currently provided by the regulations.

Due to the scope of this rulemaking, staff is conducting a preliminary workshop to discuss the proposed modifications; the Board hearing is scheduled for November, 1998. In addition to providing comments at the workshop, manufacturers are invited to discuss the proposed amendments in private meetings with staff to protect confidential information.

II. Proposed Modifications to Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Exhaust Emission Standards

A. Background

When the light-duty truck (LDT) and medium-duty vehicle (MDV) categories were first established, the majority of vehicles in these categories were primarily used for work purposes (e.g., a Ford F250 was used by electricians, plumbers, painters, etc.). Because these work vehicles have a larger load carrying capacity and a potentially more rigorous duty cycle, separate and less stringent emission standards were developed that allowed for more severe emission deterioration. The high sales numbers of full size pick-up trucks, and the more recent introduction of extremely popular sport utility vehicles (SUV), however, has greatly altered the light- and medium-duty truck categories. Whereas these vehicles were traditionally used for work purposes, it is now very common for trucks and SUVs to be used primarily for personal transportation (i.e., as passenger cars). In addition, SUVs have been increasing in market share and now constitute almost 15% of the vehicle market. *Automotive News* (October 13, 1997) reports that the U.S. vehicle market, "once dominated by cars, is approaching a car/light-duty truck split" with cars declining from 80% in 1980 to 54% in 1997. Light trucks (including SUVs) have increased from 20% in 1980 to almost 46% in 1997. This trend has a substantial impact on California's air quality because, although these vehicles are used as passenger cars, they are certified to the more lenient gram per mile (g/mi) emission standards designed for work trucks.

ARB passenger car (PC) standards traditionally do not differentiate vehicles on the basis of weight. Although PCs can be used for towing or carrying moderate loads, they are used primarily for personal transportation needs. Heavier, larger PCs have been required to meet the same emission standards as the smallest models. With the substantial increase in the number of pick-up trucks, SUVs and minivans being used primarily for the same purposes as PCs, ARB believes that they should also be required to meet PC emission standards. Due to advancements in emission control technologies, it is now estimated that emission levels from this category of vehicles can be lowered to those of PCs, and that these emission levels can be maintained for the useful life of the vehicles. Automobile manufacturers contend that although low levels of emissions are possible from this category of vehicles, it is difficult to maintain these emission levels on all vehicles because at least some portion of them will encounter more rigorous driving cycles. However, through the use of today's advanced higher durability catalysts, these vehicles should be less susceptible to deterioration effects from load carrying or towing conditions. Therefore, in this rulemaking, staff is proposing modifications to the light- and medium-duty vehicle categories by incorporating LDTs 3751-5750 lb. loaded vehicle weight (LDT2)[1] and MDVs 0-7000 lb. curb weight into one new LDT2 category (3751-7300 lb. LVW). Medium-duty vehicles above 7000 lb. curb weight (MDV4 and MDV5) would still certify to the medium-duty vehicle standards.

---

[1] For the purposes of this rulemaking, it is important to note that there are several classifications for vehicles based on weight. Curb weight is defined as the actual weight of the vehicle. Loaded vehicle weight ("LVW") is defined as the curb weight of the vehicle plus 300 lb. Loaded vehicle weight is used as the test weight for passenger cars (all weights) and light-duty trucks from 0-5750 lb. LVW. Gross vehicle weight (GVW) is the curb weight of the vehicle including the full payload. Test weight (TW), which is the test weight classification for medium-duty vehicles, is the average of a vehicle's curb weight and GVW.

Staff investigated several criteria for determining which vehicles belong in the new LDT2 category. The difficulty in selecting an appropriate vehicle weight criterion to distinguish work trucks from trucks used primarily as PCs is that this category includes not only SUVs that are mostly used for personal transportation, but also the trucks used primarily for work purposes. Curb weight was chosen because it seemed to provide the least likely opportunity for manufacturers to certify vehicles in higher weight categories perhaps in some cases to avoid the more stringent new truck category standards. Most SUVs and pickup trucks have a curb weight well under 7000 lb. (around 5000-5500 lb.,) and it would be unlikely for manufacturers to add enough weight to the vehicle to put it over the 7000 lb. curb weight limit without substantially affecting fuel economy, performance and cost. Because these vehicles are being used primarily as passenger cars, staff is also proposing to test them as passenger cars using a loaded vehicle weight basis rather than the higher test weight basis. Use of an 8500 lb. gross vehicle weight rating as a category determinant was rejected because it would be relatively easy for manufacturers to build a vehicle just above that value, thus avoiding having to certify to the new stringent standards. The type of axle (semi-floating axle vs. full floating axle) was not chosen as a differentiating criterion either because almost all of the heavier SUVs are equipped with a full floating axle as standard equipment. Vehicles above 7000 lb. curb weight would remain in the current medium-duty vehicle category.

B. Proposed Standards

Effective with the 2004 model year, staff is proposing the following modifications (listed in **bold)** to the Low-Emission Vehicle (LEV) regulations applicable to all Transitional Low-Emission Vehicles (TLEVs); Low-Emission Vehicles (LEVs); Ultra-Low-Emission Vehicles (ULEVs); and Super-Ultra-Low-Emission Vehicles (SULEVs) - (a new category for light-duty vehicles).

Table 1
Proposed LEV II Exhaust Emission Standards
(g/mi)

Vehicle Emission Category	Durability Vehicle Basis	NMOG	CO	NOx	PM*
TLEV	50,000	0.125	3.4	0.4	
	120,000	0.156	4.2	0.6	**0.04**
LEV	50,000	0.075	3.4	**0.05**	
	120,000	0.090	4.2	**0.07**	**0.01**
ULEV	50,000	0.040	1.7	**0.05**	
	120,000	0.055	2.1	**0.07**	**0.01**
SULEV	**120,000**	**0.010**	**1.0**	**0.02**	**0.01**

* Diesel vehicles only

After the 2003 model year, Tier 1 standards (0.25 grams per mile NMHC) would be eliminated as an available emission category. The 50°F multiplier for SULEVs would be 2.0 and the cold temperature carbon monoxide standard would be 10.0[2].

1. 0.05 g/mile NOx Standard

Beginning with the 2004 model year, staff is proposing that all light-duty LEVs and ULEVs meet a 0.05 g/mi NOx standard to be phased in over a three year period - 40% the first model year (2004), 80% the second model year (2005), and 100% the third model year (2006). Current certification data suggest that the proposed new standards are feasible and an ARB test program to affirm this judgment is described below.

Technology Assessment - Passenger Cars and Light-Duty Trucks (LDT1). A total of six 1998 model-year gasoline vehicles attained certification emission levels near the proposed LEV levels and three of these vehicles also achieved near ULEV emission levels, though they did not necessarily certify to these categories. Many more vehicles come very close to achieving the proposed LEV/ULEV standards. These vehicles, their emission levels, and emission controls are listed in Table 2. It is interesting to note that the emission levels for many of these vehicles do not increase significantly when aged to 100,000 miles during certification.

In achieving low emission levels, these vehicles do not appear to be using exotic or unusual emission controls. In fact, two of the vehicles utilize only one underfloor catalyst. Although nearly all of the vehicles listed in Table 2 are smaller 4 cylinder engines, there is one 8-cylinder vehicle (Ford Mustang) that displays emissions near the proposed LEV standards. Heavier vehicles with larger engines are expected to have more difficulty meeting the new requirements, so they may require more emission control capability.

---

[2] Effective with the 2002 model year, U.S. EPA is considering decreasing the cold temperature CO standards. Staff believes that the quicker light-off catalysts needed to meet the new emission standards should enable these vehicles to meet the CO standards being proposed by U.S. EPA. ARB will be monitoring this rulemaking and may make similar modifications during development of this regulation.

Table 2
1998 Model Year Vehicles With Emission Levels Below Proposed LEV/ULEV Standards

Manufacturer	Model	Emission Controls	Displacement	NMOG (50K/100K)	CO (50K/100K)	NOx (50K/100K)
Chrysler	Breeze, Stratus,Cirrus	TWC, HO2S (2), SFI, EGR	2.4 L	0.060/0.069	1.330/1.660	0.040/0.040
Ford	Mustang	TWC (6), HO2S, (4), SFI, EGR	4.6 L	0.072/0.080	1.800/2.000	0.040/0.040
Honda	Civic	TWC, HO2S (2), SFI	1.6 L	0.028/0.038	0.700/0.800	0.039/0.047
Hyundai	Sonata	CCC, TWC, HO2S (2), SFI	2.0 L	0.072/0.082	0.952/1.170	0.050/0.053
Mitsubishi	Mirage	CCC, TWC, HO2S (2), SFI, EGR	1.8 L	0.035/0.037	0.590/0.660	0.030/0.040
Nissan	Altima	CCC, TWC, HO2S (2), SFI, EGR	2.4 L	0.026/0.028	0.41/0.47	0.050/0.050

Legend: Close-Coupled Catalyst (CCC); Three-Way Catalyst (TWC); Heated Oxygen Sensor (HO2S); Sequential Fuel Injection (SFI); Exhaust Gas Recirculation (EGR);

In order to further demonstrate the feasibility of the proposed new LEV and ULEV standards for PCs, new late model year vehicles will be procured, modified and emission tested at ARB's facility in El Monte. Modifications to the emission controls are expected to consist of replacement of the OEM catalyst(s) with larger and improved catalyst(s), temporary retard of the ignition timing to increase the exhaust heat available to the catalyst after cold starts (this may depend on assistance from industry in modifying the software for the starting strategy/calibration), addition of supplemental air, and other alterations. All test vehicles will be selected based on their certification emission levels, catalyst configuration, availability of advanced catalyst systems, sales volume, and overall emission system features.

Technology Assessment - Light-Duty Trucks 3751-7300 lb. LVW (LDT2). In addition to demonstrating the technical feasibility of the proposed new LEV and ULEV standards for PCs and LDTs less than 3750 lb. LVW (LDT1), ARB is also conducting a test program to demonstrate that emissions from the new LDT2 category can be lowered to the levels established for passenger cars and LDT1s.

As part of this effort, ARB will use a 1997 model year Ford 150 truck as a test vehicle. The vehicle's specifications, emission control components and baseline emission test data are listed below. The demonstration program will be conducted in three phases. In phase I of the program, the vehicle will be tested for baseline emissions at zero miles and at 4,000 miles. During phase II of the program, the vehicle will be equipped with an advanced non-aged catalyst and optimized to lower emissions to target levels. The catalyst will be canned in an OEM exhaust system (from outlet of the engine exhaust manifold to the muffler). During the final phase of the demonstration program, the vehicle with a non-aged catalyst installed will undergo on-road mileage accumulation as much as time permits and will be emission tested at regular intervals. In demonstrating the feasibility of the proposed standards for the new LDT2s, ARB will focus primarily on using advanced catalyst technologies. Mileage accumulation will be conducted with high pay loads and some towing to simulate a fairly rigorous duty cycle. ARB staff will consider installing bench aged catalysts if agreement with industry can be achieved on an appropriate aging cycle.

Technical Specifications: 1997 Ford 150

5.4 Liter V8 Triton Engine
6.5' bed, A/C equipped
6050 lb. GVW, 4930 lb. LVW
Dual three-way Palladium-only catalytic converters;
Dual heated oxygen sensors;
Exhaust gas recirculation;
Sequential multi-port fuel injection

Table 3
Comparison of Certification Test Data and Current Emission Standards

	NMOG (g/mi)	CO (g/mi)	NOx (g/mi)	CO (20ºF)(g/mi)
50K/120K Certification Level	0.10/0.13	1.2/1.7	0.2/0.39	2.6
Current 50K/120K Standard	0.32/0.46	4.4/6.4	0.7/0.98	12.5
TARGET	**0.04/0.055**	**1.7/2.1**	**0.05/0.075**	**-**

Table 4
ARB Baseline Test Data*

	NMHC (g/mi)	CO (g/mi)	NOx (g/mi)
Test 1B	0.088	0.826	0.056
Test 2B	0.075	0.764	0.058
Test 3B	0.087	0.799	0.065
Test 4B	0.084	0.785	0.065

* Tested at 5340 lb. TW

2. 120,000 Mile Durability Standards

Currently, full useful life for PCs and LDTs is defined as 10 years or 100,000 miles, whichever first occurs. For MDVs, full useful life is defined as 11 years or 120,000 miles, whichever first occurs. Current data on vehicle miles traveled now show that, on average, PCs are driven 122,000 miles, LDTs 110,000 miles, and MDVs 118,000 miles during their first 10 years of life. The convergence of mileage accumulation among these groups suggests adoption of an updated, uniform useful life criterion. In addition, emission control systems have become more robust over the last several years as manufacturers strive to meet low-emission standards and on-board diagnostic requirements. Accordingly, staff is proposing that, for PCs and LDTs certifying to these new standards, full useful life be defined as 10 years and 120,000 miles, whichever first occurs. Table 1 reflects this proposal.

3. Proposed Super Ultra-Low-Emission Vehicle Standards

Staff is proposing the addition of a new SULEV emission category because recent technology developments indicate that gasoline, alternative fuel and hybrid electric vehicles (HEVs) could potentially reach emission levels significantly lower than the ULEV standard. Table 1 (above) contains the proposed new standards (note that the SULEV standard is a 120,000 mile only requirement).

In October, Honda announced that an advanced prototype gasoline Accord could achieve exhaust emission levels near zero. Honda has also presented data for a compressed natural gas vehicle that has emission levels one tenth of current 50,000 mile ULEV requirements at 100,000 miles. This vehicle is expected to be introduced for sale in California as a 1998 model-year vehicle. Finally, many automobile manufacturers have indicated that they are seriously considering plans to mass-produce HEVs and some manufacturers have even unveiled their close-to-production prototypes. For example, Toyota plans to market an HEV equipped with both an electric motor and a 1.5 liter gasoline engine in Japan later this year. Given the potential for some hybrid designs to utilize constant speed auxillary power unit operation and preheated catalytic converters, achieving emissions at the proposed SULEV emission level should be possible. Thus, staff is proposing the creation of a new emission standard category, SULEV, that would provide an appropriate category for these very clean vehicles. The emission values for this category represent staff's estimate of levels that can be achieved cost effectively using the best available control technology, though not necessarily the most exotic, using a variety of fuels including Phase 2 gasoline.

4. Particulate Standard

The effects of particulate matter (PM) on health and visibility are becoming an increasing concern. Due to their negative health effects, PM emissions of 2.5 microns or less in size are of special interest. In response to these concerns, the U. S. Environmental Protection Agency has promulgated new ambient air quality standards for PM less than 2.5 microns. Since mobile source emissions are a major contributor to PM of less than 2.5 microns, staff is proposing a full useful life PM standard of 0.010 g/mi for light-duty diesel vehicles and trucks less than 7000 lb. curb weight certifying to LEV, ULEV, and SULEV standards beginning in 2004. Diesel vehicles certifying to TLEV standards would be required to meet a full useful life PM standard of 0.04 g/mi. These standards are intended to provide an upper limit on PM emissions from vehicles used for personal transportation. At this time, only total particulate would be measured.

Technical Evaluation - Gasoline. Currently, light-duty vehicles and trucks certifying to federal Tier 1 requirements must meet an intermediate useful life (50,000 miles) PM standard of 0.080 g/mi and a full useful life (100,000 miles) PM standard of 0.10 g/mi. California currently does not require compliance with a PM standard for non-diesel powered vehicles.

One recent study by the Environmental Research Consortium, composed of General Motors, Ford, and Chrysler, measured an average PM exhaust level of 0.0006 g/mi on a fleet of six low mileage passenger cars tested on California Phase 2 gasoline. A group of three high mileage passenger cars tested on Phase 2 gasoline emitted an average PM value of 0.0008 g/mi. The study also measured an average PM of 0.001 g/mi on a fleet of low mileage LDTs operating on Indolene and Phase 2 gasoline. The trucks tested on Phase 2 gasoline emitted an average PM of 0.0005 g/mi. Three other trucks tested at high mileage on Phase 2 gasoline emitted an average PM of 0.002 g/mi. The model years of the vehicles in this study ranged from 1994 to 1997. None of the vehicles tested exceeded 0.002 g/mi PM. Since available data indicate that properly functioning gasoline-fueled vehicles emit PM at levels well below 0.010 g/mi, ARB is proposing that non-diesel vehicles remain exempt from the proposed PM standards. ARB solicits comments on whether extending a PM requirement to any alternative fuels is warranted.

Technical Evaluation - Diesel. Light-duty diesel vehicles certifying to TLEV standards are currently required to meet a California PM useful life (100,000 miles) standard of 0.08 g/mi. Light-duty diesel vehicles certifying to LEV and ULEV standards must meet a full useful life PM standard of 0.04 g/mi. Chassis-certified medium-duty diesel LEVs are required to certify to a full useful life (120,000) PM standard of 0.08 g/mi, while medium-duty ULEVs must meet a 0.04 g/mi PM standard.

The data for light-duty diesel vehicles suggest that significantly more development is needed for these vehicles to meet a 0.010 g/mi PM standard. Furthermore, given the low NOx requirements being proposed for the LEV and ULEV categories and the difficulty associated with simultaneously achieving both low NOx and PM emissions from diesel engines, it is unclear whether diesel vehicles will be able to achieve these levels for the foreseeable future. Two light-duty diesel vehicles recently certified in California have demonstrated PM emissions of 0.05 g/mi and NOx emissions of 0.7 g/mi. With further improvements in engine controls and lean-NOx catalyst technology in the next few years, light-duty diesel vehicles may be able to at least certify to the proposed TLEV standards.

C. Proposed Fleet Average Requirements

Beginning with the 2004 model year, separate fleet average requirements for passenger cars and LDTs 0-3750 lb. LVW and LDTs 3751-7300 lb. LVW would be established. These are shown in the tables below (staff chose a scenario judged to be feasible in the 2004-2010 time frame - only the fleet average would be a regulatory requirement; manufacturers could choose their own implementation schedule as long as the fleet average requirement is met each year).

Table 5
Implementation Rates for TLEVs, LEVs, ULEVs, SULEVs, and ZEVs Used to Calculate Fleet Average Standards for Passenger Cars and Light-Duty Trucks 0-3750 lb. LVW

Model Year	TLEV	LEV	ULEV	SULEV	ZEV	Fleet Average Requirement
2004	2	48	35	5	10	0.053
2005	2	40	38	10	10	0.049
2006	2	35	41	12	10	0.046
2007	1	30	44	15	10	0.043
2008	1	25	44	20	10	0.040
2009	1	20	49	20	10	0.038
2010	1	15	49	25	10	0.035

Because trucks in the new LDT2 category are not as far along in meeting the proposed emission standards as PCs, and because there is no zero-emission vehicle (ZEV) requirement for LDTs 3751-5750 lb. LVW or medium-duty vehicles 0-8500 lb. TW, the fleet average requirement being proposed would be slightly higher than those for PCs.

Table 6
Implementation Rates for TLEVs, LEVs, ULEVs, SULEVs, and ZEVs
Used to Calculate Fleet Average Standards for Light-Duty Trucks
3751-7300 lb. LVW

Year	TLEV	LEV	ULEV	SULEV	Fleet Average
2004	2	75	21	2	0.067
2005	2	65	31	2	0.064
2006	2	55	38	5	0.059
2007	1	45	49	5	0.055
2008	1	35	54	10	0.050
2009	1	25	64	10	0.047
2010	1	20	64	15	0.043

Preliminary tpd estimates indicate that the current proposal would meet the expected emission reductions of SIP Measure M2 as well as provide additional reductions applicable to the Black Box. An assessment of the anticipated tpd reductions will be provided in the final Staff Report to be released prior the Board hearing in November 1998.

D. Optional 150,000 mile Durability Standard. The ARB's Emission Inventory shows that approximately 20% of all vehicle miles traveled are with vehicles that have mileage between 100,000 and 150,000 miles. Emissions from these vehicles represent a significant portion of the emission inventory. In order to ensure that these vehicles are durable even after their useful life (120,000 miles), staff is proposing an optional 150,000 mile standard equal to the applicable 120,000 mile standard. Manufacturers that certify to this optional standard would receive additional NMOG credits towards compliance with the fleet average requirements.

E. Diesel Light-Duty Trucks. With the greater numbers of sport utility vehicles, there is a potential for an increase in the sale of diesel trucks in order to meet federal fuel economy requirements. Therefore, staff is proposing that all diesel trucks that would fall into the lower end of the new light-duty truck category be certified using the chassis test procedure. Although LDTs 0-5750 lb. LVW must chassis certify under the current regulations, diesel medium-duty vehicles have the option to certify using the engine test procedure (above 8500 lb. GVW). Thus staff is proposing that medium-duty vehicles that fall under the proposed cut point of 7000 lb. curb weight and under 8500 lb. GVW in this particular case would have to certify using the chassis test procedure. Thus many of the diesel trucks now in this category could continue to engine certify, but adding diesel engines to SUVs and lighter trucks would require chassis certification.

III. Partial ZEV Credits

Staff has spent considerable time evaluating the ZEV program and the appropriate policies that would achieve the greatest long-term emission benefits for California. While ARB will not revisit the ZEV requirements during this rulemaking, staff is considering providing partial ZEV credits to some qualifying technologies.

ARB continues to believe that ZEV technologies such as battery electric vehicles and hydrogen fuel cell vehicles with zero emissions of regulated pollutants should be strongly encouraged because, unlike other technologies, they do not exhibit emission increases with age. Although new vehicles have more durable emission controls, on-board diagnostic systems are effective in alerting owners to problems, and Smog Check enforces emission system maintenance, as vehicles age, they continue to present problems. Smog Check cost limits may permit continued operation of high emitters, owners may not respond to “check engine” lights promptly, a significant number of cars are not registered, and other problems continue to hamper achieving clean air. Zero emission vehicles do not have these kinds of associated problems.

Nonetheless, a variety of new propulsion systems are also emerging with surprisingly low emission characteristics, including natural gas and gasoline conventional vehicles, reformer-equipped fuel cell vehicles, hybrid electric vehicles and others. For some of these vehicles, providing partial ZEV credit may be important to help build sales volume to achieve the economies of scale needed to make them more competitive with vehicles currently dominating the market. Large numbers of these very clean technologies would contribute substantially to improving California’s air quality and should be encouraged. ARB staff, therefore, believes that it is appropriate to create incentives for the cleanest technologies that provide near zero emissions by providing them with partial ZEV credit.

Fuel cell vehicles are gaining considerable interest, especially with Daimler Benz’s bold announcement that they expect to have 100,000 fuel cell vehicles on the road by 2005. Daimler Benz also recently formed a $325 million joint venture with Ballard Power Systems to make this happen. Daimler Benz has demonstrated a stored hydrogen fuel cell ZEV (NECAR II), and more recently has shown their new “A” class urban vehicle (NECAR III) equipped with a methanol reformer fuel cell system to help address range and refueling infrastructure issues. Because of the zero-emission characteristics of the stored hydrogen fuel cell vehicle and the potentially near zero characteristics of methanol reformer vehicles (or possibly other types of fuel reformers), ARB is strongly interested in encouraging these technologies.

Honda also recently announced it has developed a gasoline prototype Accord that has achieved near zero tailpipe emissions. Honda believes they may be able to offer such a vehicle in a few years once they have addressed cost issues, on-board diagnostic capability and possibly others.

Hybrid electric vehicles can also achieve near zero emissions, especially the series configurations with auxiliary power units that can operate at steady speeds for optimum emission control. Series hybrids can also operate using only battery energy in the all-electric mode to provide some portion of zero emission driving.

Partial ZEV Credit Criteria. Given these impressive accomplishments, staff intends to propose that these vehicles receive partial ZEV credit and be permitted to meet a portion of each manufacturer's ZEV requirement.

1. **Vehicles with no significant zero-emission range** meeting the proposed SULEV emission standard would receive partial ZEV credit based on such considerations as capability of the OBD II system to monitor the emission controls and signal malfunctions when emissions are close to the SULEV standard, fuel cycle emissions associated with the fuel being used, emission deterioration characteristics, and perhaps other factors. ARB staff proposes that such vehicles would be permitted to satisfy up to 40% of a vehicle manufacturer's required ZEV sales volume. ARB staff will be developing a partial ZEV credit proposal for presentation at the workshop. Each of these vehicles would also be counted in a manufacturer's fleet average as a SULEV.

2. **Vehicles providing significant zero-emission range** with auxiliary power units meeting the SULEV emission standard would also receive partial ZEV credit based on their all electric range coupled with factors associated with the auxiliary power unit, as above. Staff is particularly interested in control system strategies that maximize operation solely on electric power before allowing activation of the auxiliary power unit. Staff proposes that hybrid electric vehicles be permitted to satisfy up to 60% of a manufacturer's ZEV sales volume requirement. These vehicles would be permitted to satisfy a higher percentage of a manufacturer's ZEV requirement because they provide some zero-emission travel and also increase the production volume of some advanced batteries and fuel cells, thereby helping to reduce their cost.

3. **Fuel reformer-equipped fuel cell vehicle** emissions need to be further evaluated, but early indications are that their emissions are likely to be quite low, with some fuels exhibiting lower emissions than others. The staff intends to propose partial ZEV credits for these vehicles and also to allow them to satisfy a portion of a manufacturer's ZEV requirements, but much more data is needed before a specific proposal could be made.

In addition to placing a cap on the partial ZEV credits that can be earned for each of the vehicle types mentioned above, staff proposes that manufacturers could satisfy a maximum of 60% of their ZEV sales volume requirement with partial ZEV credits. Accordingly, manufacturers producing a mix of vehicle types that can earn partial ZEV credits would still be required to meet 40% of their ZEV requirement with pure ZEVs.

Staff proposes to reserve 40% of the ZEV requirement for pure ZEVs to ensure sufficient production volume of batteries, stored hydrogen fuel cells or other non-emission technologies that can not deteriorate. Maintaining this production requirement can help achieve economies of scale necessary to make them affordable and fully competitive with conventional vehicles in the 2005 to 2010 time frame. Generally, battery manufacturers estimate that economies of scale level out after production of 200,000 to 300,000 packs.

As part of the methodology for providing partial ZEV credits, staff is considering allowing alternative approaches to ozone reduction, such as the "PremAir" catalyst. Staff would develop specific methodologies to provide credit according to their ozone-reducing capability. While calculating the credit, factors such as availability of ozone for reduction would be taken into consideration.

Overall, the above proposal should allow a smoother ramp-up to the ZEV volumes required beginning in 2003, create incentives for new near term zero-emission technologies, and maintain the pure ZEV development efforts - and eventually yield even more near zero emission reduction options than might otherwise be achieved. ARB staff encourages workshop participants to consider this proposal carefully, and to work with staff to constructively refine the proposal to ensure fairness and competitiveness of all of these advanced technologies.

IV. Proposed Amendments to California's Enhanced Evaporative and Onboard Refueling Vapor Recovery Emission Regulations ("Zero-Evap")

A. Proposal. Despite the current stringent "enhanced evaporative" regulations, evaporative reactive organic gas (ROG) emissions from vehicles meeting these standards are estimated at 0.07 g/mi, or 1.4 times exhaust emissions from LEV vehicles in the year 2010 (EMFAC7G). Evaporative emission inventories beyond 2010 will become relatively greater than exhaust ROG inventories as the fleet average NMOG exhaust emission rates are reduced. Therefore, staff is proposing amendments to the enhanced evaporative and refueling standards and test procedures that will establish zero evaporative emission standards and test procedures (within the limits of current measurement technology). These regulations are referred to as the "zero-evap" regulations. The ARB staff welcomes comments regarding these proposed standards and the techniques necessary for measurement of the emissions levels proposed.

B. Applicability. Staff is proposing that these emission standards and test procedures be phased-in beginning in the 2004 model-year for new PCs, LDTs, MDVs, and heavy-duty vehicles (consistent with the current enhanced evaporative and refueling emission requirements). The proposed phase-in schedule is 40 % compliance in the 2004 model year, 80% in the 2005 model year, and 100% in 2006 and subsequent model years. Both medium-duty (more than 7300 lb. LVW under the proposed LEV II regulations) and heavy-duty vehicles will demonstrate compliance with evaporative standards based on engineering evaluation, as performed under the current enhanced evaporative requirements.

The proposed evaporative and refueling regulations would be applicable to gasoline-fueled, liquefied petroleum gas-fueled, alcohol-fueled, and hybrid electric vehicles. Zero emission vehicles with fuel fired heaters would also be included.

C. Proposed Standards. Beginning in the 2004 model year, staff proposes that vehicles subject to the evaporative emission regulations be required to emit zero evaporative emissions during testing. Since the background ROG levels in the test facility and ambient air may be greater than zero, background levels may contribute to the ROG evaporative emission level measured from a test vehicle. A better quantification of the background level and a method to adjust the test results may be needed.

In addition, staff is proposing to extend the current 100,000 mile/10 years durability requirements to 150,000 mile/15 years. Because exhaust emission control systems experience much harsher operating conditions (high temperatures and more severe mechanical vibrations) than those experienced by evaporative and refueling emission control system components, staff believes that evaporative and refueling components could have greater durability requirements. Furthermore, current in-use data suggest that a significant number of older vehicles develop liquid fuel leaks that result in emissions of several orders of magnitude greater than newer vehicles. Staff believes these very high emission levels can be eliminated by a more stringent durability requirement.

Technical Feasibility. In the past few months, staff has obtained information from a few manufacturers on various types of zero evaporative designs. Currently, staff is performing testing on a prototype zero evaporative vehicle. This vehicle is being tested at ARB's enhanced evaporative test facility in El Monte, California. Preliminary test results show that hot soak and diurnal emissions are controlled to under 10% of the current 2-gram evaporative standard. Staff is also making efforts to obtain additional zero evaporative gasoline-fueled vehicles from manufacturers in order to obtain additional emission data. Presently, staff has identified the following technologies as potential components of a zero evaporative fuel system design:

- Improvements to current enhanced evaporative systems, including sealed fuel systems to reduce diurnal, hot-soak, and running loss emissions, use of an auxiliary canister set in series with the main canister to catch any residual diurnal and hot-soak emissions, and use of an air intake carbon filter to reduce engine breathing losses
- Bladder fuel tank systems
- Pressurized fuel tanks
- Pressurized vapor reservoir systems
- Improved insulated fuel tanks
- Improved mechanically sealed ORVR systems

In addition to the above, staff has gathered information on a number of vehicles that show certification emissions levels at or below 20% of the current standard for either diurnal plus hot-soak emissions, or re-fueling emissions (see Tables 7 and 8).

Table 7
Low-Evaporative Emitting Vehicles
(Diurnal+Hot-Soak Standard at 2 grams, Running Loss at 0.05 g/mi)

Vehicle	Engine Displacement (liters)	Emissions Levels (Diurnal+ Hot Soak in grams, Running Losses in g/mi)
Acura Integra	1.8	0.4 g / 0.01 g/mi
Honda Civic	1.6	0.3 g / 0.01 g/mi
Hyundai Accent	1.5	0.4 g / 0.03 g/mi
Toyota Avalon	3.0	0.4 g / 0.02 g/mi
Toyota Camry	2.2	0.4 g / 0.02 g/mi
Toyota Camry	3.0	0.4 g / 0.02 g/mi
Toyota Corolla	1.8	0.3 g / 0.02 g/mi
Toyota Tercel	1.5	0.4 g / 0.01 g/mi
Toyota 4-Runner	2.7	0.4 g / 0.01 g/mi

Table 8: Low Refueling Emissions Vehicles (Standard at 0.2 grams/gal)

Vehicle	Engine Displacement (liters)	Emissions Levels (g/gal)
Audi Passat	2.8	0.00*
Mercedes SL 500	5.0	0.01*
Ford Escort	2.0	0.04
Hyundai Elantra	1.8	0.02
Hyundai Tiburon	2.0	0.03
Nissan Altima	2.4	0.04
Toyota Camry	2.2	0.004
Toyota Corolla	1.8	0.006
Volvo 570	2.4	0.03

* Mechanical seal type ORVR systems

The results shown above suggest that significantly lower evaporative and refueling emissions are quite feasible today. The vehicles shown do not generally employ a technologically advanced control system, and use of such a system would be expected to lower emissions significantly from these levels. Staff recognizes that most of these vehicles are 4-cylinder vehicles; this implies easier control of evaporative emissions but not of refueling emissions (since refueling is measured on a gram/gallon basis). Staff believes that much of the reason for these lower evaporative results is improved control of fuel permeation losses, aided by the smaller fuel systems used on 4-cylinder vehicles. However, improved fuel permeation control can also be achieved by better sealing of the fuel system itself, as mentioned previously. Staff has not evaluated the reasons for the low refueling losses above; possible reasons include improved filler-neck seals or the use of relatively larger canisters.

D. Test Requirements/Facilities. Staff is proposing that the major elements (hot soak, diurnal, and running loss) of the current enhanced evaporative test procedures be performed for zero-evap testing. Staff is also considering alternative evaporative test procedures for zero-evaporative vehicles that can demonstrate zero evaporative emissions by engineering evaluation and/or the use of a simplified test procedure.

Staff is also proposing that compliance with the new standards be demonstrated using current enhanced evaporative test facilities. Current enhanced evaporative test facilities are required to have a hydrocarbon mass resolution of 0.01 grams. Staff believes that this level of detection is sufficient in determining zero evaporative emissions. Furthermore, speciation of test results would be performed for samples that marginally exceed the standard in order to differentiate between fuel and non-fuel related sources.

V. New Supplemental Federal Test Procedure Emissions Standards.

Along with the proposed reductions in LEV, ULEV and SULEV FTP exhaust standards, staff is proposing reductions in the Supplemental Federal Test Procedure (SFTP) emission standards for these categories, as adopted by the Board at a public hearing on July 24, 1997. The SFTP contains two tests designed to limit emissions during air-conditioner usage and during high-speed, high-acceleration driving. These tests are known as the A/C test and the US06 test, respectively. The operating conditions in these tests are not significantly represented on the current FTP test. The standards adopted by the Board begin their phase-in schedule in the 2001 model-year, and are shown in the table below. SFTP standards for TLEVs are not shown as no change is proposed for these standards. Present certification classes of PCs, LDTs, and MDVs are employed.

Table 9
SFTP 4,000-Mile Standards for 2001 and Later Model Year
LEV, ULEV and SULEV Vehicles (g/mi)

	US06 Standards		A/C Standards	
Vehicle Class	**NMHC+ NOx**	**CO**	**NMHC+ NOx**	**CO**
PC/LDT1	0.14	8.0	0.20	2.7
LDT2	0.25	10.5	0.27	3.5
MDV2	0.4	10.5	0.31	3.5
MDV3	0.6	11.8	0.44	4.0

These standards were adopted by the Board following lengthy staff discussions with the automotive industry, and represent emission standards of approximately equal stringency to the current FTP standards. Staff is now proposing to lower these SFTP standards concordantly with the new FTP standards being proposed and the re-classification of virtually all vehicles above into the PC and new light-duty truck classes.

For the LEV and ULEV vehicles, staff is proposing FTP NOx levels of 0.05 g/mi. This is a reduction of 75% in NOx levels from the current LEV and ULEV levels of 0.2 g/mi. For the SULEV vehicles, FTP NOx levels of 0.02 g/mi are being proposed, or a 90% reduction from current LEV levels. These percentage reductions are employed to calculate appropriate SFTP NMHC+NOx emissions standards, as most of these emissions are NOx emissions. These standards would be phased in beginning with the 2005 model year for PCs and LDT1s as follows: 40% the first model year, 80% the second model year; and 100% in the third model year. For the new LDT2 category, these standards would be phased in beginning with the 2006 model year in the same percentages: 40% in the first model year, 80% in the second model year and 100% in the third model year. In addition, it is expected that percentage reductions in FTP NOx levels will lead to comparable reductions in SFTP NOx levels, provided the vehicles are properly calibrated for the SFTP. The SFTP emission levels below are therefore being proposed for PCs and LDT1s and the new LDT2 class.

Table 10
SFTP 4,000 Mile Emission Standards for 2005 and Later Model Year
LEV, ULEV, and SULEV Passenger Cars and Light-Duty Trucks (g/mi)

	US06 Standards		A/C Standards	
Emissions Class	**NMHC+NOx**	**CO**	**NMHC+NOx**	**CO**
LEV, ULEV	0.035	8.0	0.05	2.7
SULEV	0.014	8.0	0.02	2.7

Vehicles performing at or below these levels have already been observed in ARB testing. The Honda ULEV prototype, a vehicle similar to the production 1998 Honda ULEV, demonstrated US06 levels at 100,000 miles of aging of 0.025 g/mi NMHC+NOx, and 0.35 g/mi CO. Emission levels at 4,000 miles on this vehicle would be expected to be significantly lower.

Three additional vehicles have performed near or below the proposed A/C standards. The first, a Mazda LEV/ULEV prototype, demonstrated A/C NMHC+NOx results of 0.063 g/mi, while two larger Ford Tier 1 vehicles, an F-150 pick-up truck and an Econoline 15-passenger van, showed results of 0.091 and 0.046 g/mi, respectively. It is expected that the two Ford vehicles, if redesigned as LEVs or ULEVs, would show significantly lower emissions than presented here.

The ARB plans to test additional vehicles over the US06 and the A/C tests to further explore the feasibility of the proposed standards.

VI. Proposed Test Procedures for Hybrid Electric Vehicles

Over the past several years, ARB has been involved with the development of hybrid-electric vehicle (HEV) test procedures for California certification. In addition to in-house staff analysis and discussion, ARB has worked with HEV industry groups and has initiated an HEV test program. To date, ARB has evaluated two Ford Ecostar sodium-sulfur HEVs, two Mitsubushi HEVs (with lead-acid and lithium-ion battery packs), and other early prototype HEV designs. ARB has also participated in discussions with members of the Society of Automotive Engineers (SAE) HEV task force to support the development of Federal HEV test procedures. Cooperation with SAE is a major element of ARB's HEV test procedure development program and will hopefully result in test procedures that will eventually will be applicable in California and the other forty nine states.

Although ARB recognizes the need for comprehensive testing of HEVs in order to capture all possible operating modes and fully represent potential real world consumer use, there is also the need to establish a simplified HEV test procedure adequate for the California certification process. The current draft SAE HEV test procedure dated October 10, 1997, includes three components (HEV classification, testing, and weighting of results) that attempt to evaluate all possible HEV designs. In order to minimize the testing burden on the automotive industry and still achieve HEV test results adequately representing likely in-use operation and emission levels, ARB is currently seeking public and industry input to assist in the formulation of more abbreviated HEV test procedures for California certification.

During the workshop, staff will present ARB's draft HEV test procedures for public review. Staff would also welcome presentations from industry outlining possible approaches to distilling a simplified test procedure from the current SAE document that would facilitate hybrid certification.

VII. Proposed Modifications to Calculation of Smog Index

Smog indices were adopted for light-duty vehicles beginning in 1998 to provide consumers with an indication of the relative contribution of different new light-duty vehicles to smog formation based on their exhaust and evaporative HC and NOx emissions. At that time, diesel vehicles were not included in the smog index calculations and Tier 1 gasoline vehicles certified to the old evaporative standards were assigned a baseline smog index value of 1.00. This proposal includes updates to the current smog index calculations to include diesel vehicles, assigns a smog index value of 1.00 to gasoline vehicles certified to the new more stringent evaporative standards, and provides revised and enhanced smog index calculations that reflect the changes to the Low-Emission Vehicle Regulations that are being proposed at this time for post-2003 model-years. Hence, the proposed change will provide new vehicle purchasers a more accurate indication of how "clean" a new vehicle is relative to other new vehicles available for purchase within the time frame the new smog indices become effective in 2000 and subsequent model years.

A. Changes to Smog Indices for 2000-2003 Model Years.

1. Assign 2000 Model-Year Tier 1 Gasoline Passenger Cars a Smog Index Value of 1.00. When smog indices were originally developed, Tier 1 vehicles that certify to the old evaporative emission standards (2.0 gram 1-hour diurnal plus hot soak HC/test at 50,000 miles) were assigned a smog index value of 1.00. Beginning with the 1999 model-year, new vehicles will no longer be able to certify to the old evaporative emission standards. It is, therefore, more appropriate to recalculate the smog indices recognizing that all new vehicles sold within the applicable time frame will meet more stringent new evaporative emission standards (2.0 gram 3-day diurnal plus hot soak HC/test and 0.05 gram running loss HC/test, both at 100,000 miles).

2. Create a Single Set of Smog Indices for all Light-Duty Vehicles. As mentioned earlier, the current trend in light-duty vehicle purchasing shows an increasing consumer preference towards sport-utility vehicles and pickup trucks. An often overlooked consequence of this shift in vehicle selection is the air quality penalties associated with these heavier vehicles, which are currently subject to less stringent emission standards than PCs. It is unlikely that there is much recognition by purchasers of new vehicles that the choice of these larger vehicles rather than conventional cars is detrimental to air quality. Therefore, the ARB is proposing to adopt smog indices that combine light-duty PCs and trucks into one scale.

3. Include Tier 1, Option 2 Diesel Vehicles in Smog Index Calculation. In addition, since current smog index requirements do not specifically address vehicles certifying to the 100,000 mile (Tier 1, Option 2) diesel-specific standards (0.31 g/mi NMHC, 4.2 g/mi CO, and 1.0 g/mi NOx), these vehicles will also be included in the proposed smog indices for model years 2000 and beyond.

Accordingly, staff is proposing new smog indices for model years 2000 through 2003 as follows:

Table 11
Passenger Cars and Light-Duty Trucks 0-3750 lb. LVW

Vehicle Category	Smog Index
Tier 1 (Option 2) Diesel	1.16
Tier 1 (enhanced evap.)	1.00
Tier 1 (evap. test exempt)*	0.82
TLEV (enhanced evap.)	0.84
TLEV (evap. test exempt)*	0.66
LEV (enhanced evap.)	0.53
LEV (evap. test exempt)*	0.35
ULEV (enhanced evap.)	0.48
ULEV (evap. test exempt)*	0.30
ZEV	0.00

* Vehicles exempt from evaporative test requirements because they have no evaporative emissions

Table 12
Light-Duty Trucks 3751-5750 lb. LVW

Vehicle Category	Smog Index
Tier 1(Option 2) Diesel	1.77
Tier 1(enhanced evap.)	1.47
Tier 1(evap. test exempt)*	1.29
TLEV (enhanced evap.)	1.27
TLEV (evap. test exempt)*	1.09
LEV (enhanced evap.)	0.81
LEV (evap. test exempt)*	0.63
ULEV (enhanced evap.)	0.75
ULEV (evap. test exempt)*	0.57
ZEV	0.00

* vehicles exempt from evaporative test requirements because they have no evaporative emissions

4. **Fleet Average Smog Indices for Model Years 2000-2003**. Including fleet average smog indices on the Smog Index Label would also provide the consumer with an indication of the relative impact on ozone formation of a given vehicle relative to the fleet average emissions of the new vehicle fleet. A consumer could then make an informed choice to purchase a vehicle cleaner than the average vehicle of the new vehicle fleet. Staff is, therefore, proposing that the fleet average smog index be added to the smog index label with a sentence indicating the relative impact of each vehicle on ozone compared to the fleet average emissions. The fleet average smog indices for model years 2000-2003 are based on the vehicle mix used to calculate the fleet average standard contained in the 1990 staff report for the Low-Emission Vehicle Regulations.

Table 13
Fleet Average Smog Indices

Model Year	Fleet Average Smog Index
2000	0.60
2001	0.56
2002	0.55
2003	0.52

B. Proposed Smog Indices Post-2003 Model-Year

Staff is proposing new smog indices based on the following assumptions:

1. Beginning in 2004, vehicles will no longer be allowed to certify to Tier 1 standards. Therefore, a smog index of 1.00 will be assigned to a gasoline TLEV beginning with the 2004 model year.

2. Light- and medium-duty trucks weighing 0-7300 lb. LVW are subject to the lower emission standards to which PCs must comply and all PCs and trucks in this category are combined into one smog index scale.

3. LEV and ULEV NOx emission standards for 2004 and subsequent model-year light- and medium-duty vehicles (0-7300 lb. LVW) would decrease from 0.2 g/mile to 0.05 g/mile. The phase-in of these standards is 40 percent in 2004, 80 percent in 2005, and 100 percent in 2006 and beyond. This phase-in is reflected in table 15.

4. The creation of the new SULEV category of emission standards for light- and medium-duty vehicles (0-7300 lb. LVW). The NMOG and NOx emission standards for SULEVs that are being considered are 0.010 g/mile and 0.02 g/mile, respectively.

5. The fleet average smog indices are modified to reflect the more stringent fleet average standards for 2004 and subsequent model years and that all vehicles certify to the

enhanced evaporative emission standards. In addition, it is anticipated that the market for sport-utility vehicles and light pickups will increase to 50 percent of the new light-duty vehicle fleet over the next ten years. Consequently, the fleet average smog indices for the 2004-2010 model-years assume an even split between PCs and trucks 0-7300 lb. LVW. The proposed smog indices and fleet average smog indices are as follows:

Table 14
All Light-Duty Vehicles 0-7300 lb. LVW

Vehicle Category	Smog Index
TLEV (enhanced evap.)	1.00
TLEV (evap. exempt)	0.79
LEV (enhanced evap., NOx=0.2 g/mi)	0.62
LEV (evap. test exempt, NOx=0.2 g/mi)*	0.41
LEV (enhanced evap., NOx=0.05 g/mi)	0.40
LEV (evap. test exempt, NOx=0.05 g/mi)*	0.19
ULEV (enhanced evap., NOx=0.2 g/mi)	0.57
ULEV (evap. test exempt, NOx=0.2 g/mi)*	0.36
ULEV (enhanced evap., NOx=0.05 g/mi)	0.35
ULEV (evap. test exempt, NOx=0.05 g/mi)*	0.14
SULEV (enhanced evap.)	0.26
SULEV (evap. test exempt)*	0.05
ZEV	0.00

* vehicles exempt from the evaporative test requirements because they have no evaporative emissions

Table 15
Fleet Average Smog Indices

Model Year	Fleet Average Smog Index
2004	0.49
2005	0.40
2006	0.36
2007	0.35
2008	0.34
2009	0.34

2010	0.33

VIII. Update to Reactivity Adjustment Factors

A. Background - Accounting for Exhaust Reactivity. To account for the varying reactivity of vehicle exhaust, the LEV program contains a mechanism under which the full mass of NMOG emissions from vehicles operating on alternative or reformulated gasoline fuels is adjusted by the applicable reactivity adjustment factor (RAF). RAFs are based on a comparison of the ozone reactivity of an alternative fuel or reformulated gasoline low-emission vehicle to the ozone reactivity of a comparable conventional gasoline low-emission vehicle. The RAF is calculated as shown below:

$$RAF = \frac{\text{ozone/gram of clean fuel low-emission vehicle NMOG emissions}}{\text{ozone/gram of conventional gasoline low-emission vehicle NMOG emissions}}$$

Manufacturers have two options when utilizing a RAF for a given fuel. They can establish their own specific reactivity for a particular engine family (to be used in the numerator of the RAF equation) or they can use the generic RAF developed by the ARB that applies to all vehicles and fuels in a given emission category (TLEV, LEV or ULEV). Both options utilize the same baseline specific reactivity (the denominator of the RAF equation) determined by ARB.

B. Reactivity Adjustment Factors. The table below identifies the baseline specific reactivities and RAFs that have been adopted thus far. These are interim RAFs effective through the 2000 model year.

Table 16
Reactivity Adjustment Factors

	Light-Duty Vehicles			**Medium-Duty Vehicles**	
	TLEV	**LEV**	**ULEV**	**LEV**	**ULEV**
Fuel	**Baseline Specific Reactivity (g O3 / g NMOG)**				
Conventional Gasoline	3.42	3.13	3.13	3.13	3.13
	RAFs				
Phase 2 RFG	0.98	0.94	0.94	0.94	0.94
M85	.041	0.41	0.41	0.41	0.41
Natural Gas	1.0	0.43	0.43	0.43	0.43
LPG	1.0	0.50	0.50	0.50	0.50
E85	-	-	-	-	-

C. RAF Confirmatory Testing. When the RAFs were adopted, ARB indicated that it would conduct confirmatory testing of production vehicles to determine whether the RAFs needed to be changed beyond 2000 to reflect the exhaust reactivity of production low-emission vehicles. Staff has been conducting testing to verify the reactivity adjustment factors for TLEVs, LEVs and ULEVs operating on Phase 2 RFG. Testing has not yet been completed due to the limited numbers of LEV and ULEV vehicles available for testing. It should be noted that the MTBE content of the test fuel used was marginally out of specification. However, this is expected to have a minimal effect on exhaust reactivity measured and ARB is in the process of procuring test fuel meeting the correct MTBE specification. Staff will continue to test vehicles as they become available. The testing conducted to date is summarized below:

Table 17
Production TLEV Specific Reactivity

Manufacturer	Model	Model Year	Fuel	O3/NMOG
Ford	Grand Marquis	1996	Phase 2	3.855
Ford	Escort	1997	Phase 2	4.002
Chrysler	Neon	1996	Phase 2	3.939
Chrysler	Intrepid	1997	Phase 2	3.727
Nissan	Sentra	1996	Phase 2	3.390
Honda	Accord	1996	Phase 2	N/A
			Average	3.783

Table 18
Production LEV Specific Reactivity

Manufacturer	Model	Model Year	Fuel	O3/NMOG
Ford	Escort	1997	Phase 2	3.925
Ford	Sable	1997	Phase 2	3.985
Toyota	Camry	1997	Phase 2	3.969
Nissan	Sentra	1997	Phase 2	3.890
Honda	Civic	1996	Phase 2	3.494
Suzuki	Metro	1997	Phase 2	3.250
			Average	3.752

The data to date shows an increase in the TLEV generic RAF from 0.98 to 1.11 and increase in the LEV generic RAF from 0.94 to 1.20.